Introduction to Computer Vision, 2014

Final Exam

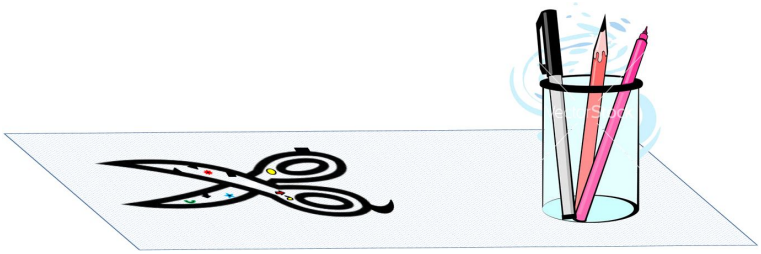
- Answer the following 3 questions.
- You may write your answers either in Hebrew or in English.
- Length of exam: 3 hours.

Good luck!

Q1:

1. Is it possible to discretely sample a function $f : \Re \longrightarrow \Re$ at uniform finite distances without loosing any information? (i.e., can we sample $f(x)$ discretely, and be able to reconstruct the complete $f(x)$ back from its discrete samples?) Explain when.
2. $f(x)$ is a continuous function whose maximal frequency is Ω. The following operations are performed on the continuous function $f(x)$. For each case, explain what is the maximal allowed distance between samples in order not to loose any information:
   (a) Shifting f:
   $g(x) = f(x - 3)$.
   (b) Differentiating f:
   $g(x) = f'(x)$.
   (c) Squaring f:
   $g(x) = f^2(x)$.
   (d) Convolving f with a shrunk version of itself:
   $g(x) = f(x) * f(2x)$.
3. Are the following functions band limited, and if so, what is their maximal frequency in each direction?
   (a) $g(x) = sin(x) * cos(x)$
   (b) $g(x, y) = sin(x) * cos(y)$

   (where '$*$' denotes convolution)



Q2:

1. A camera is imaging the scene in the picture above, resulting in image I_1. The camera is then rotated, and a second picture I_2 of the scene is taken. The camera is then moved to another location, and a third picture I_3 of the scene is taken.
   (a) What is the geometric relation between the images I_1 and I_2? What is the minimum number of corresponding points between the two images required in order to recover this relation?
   (b) Same question as above for I_1 and I_3?
2. The camera now zooms in, so that it sees only the flat scissors, producing image I_4. The camera is then moved again to another position, taking another picture of the scissors, resulting in image I_5. What is the geometric relation between the images I_4 and I_5? What is the minimum number of corresponding points between the two images required in order to recover this relation?
3. The experiment in item 2 is repeated, but this time the opening angle between the two arms of the scissors is changed between the time I_4 is taken and the time I_5 is taken. Assume point correspondences between I_4 and I_5 are provided for each arm of the scissors (as many points as necessary). How can the axis point of the scissors be recovered?

Q3: Explain briefly the following concepts:

1. Informative features
2. K-means clustering
3. SVM
4. HoG descriptor